PATENT SPECIFICATION (11) 1 245 589

1245589

DRAWINGS ATTACHED

(21) Application No. 18423/68 (22) Filed 18 April 1968

(23) Complete Specification filed 15 April 1969

(45) Complete Specification published 8 Sept. 1971

(51) International Classification B 23 k 9/12

(52) Index at acceptance
B3R 32D2 32J 36 37A1A
G3R 20 4
H2J 12A 12H2 2C 2G4A

(72) Inventor BRIAN JOHN SEVERY

(54) IMPROVEMENTS IN WELDING APPARATUS

(71) We, LINCOLN ELECTRIC COMPANY LIMITED, a British Company, of Black Fan Road, Welwyn Garden City, Hertfordshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to improved apparatus for electric arc welding, and particularly to apparatus for pre-heating an electrode prior to striking an arc, and maintaining the arc in a stable condition when struck.

It is known to provide apparatus for electric arc welding which comprises a main welding current source arranged to supply current to a welding circuit comprising a movable wire electrode and a workpiece; a control generator, arranged in opposition to the main welding current source and connected in series with an electrical motor which is arranged to drive the electrode wire toward or away from the workpiece in accord with the difference between the output voltages of the source and control generator, the control generator and motor being in parallel with the welding circuit.

In order to explain the purpose of the present invention, the operation of a typical prior example of such apparatus will first be described. In this example, the main welding current source is an electrical d.c. generator. The control current generator and electrical motor are also connected across the welding circuit in such a way that when the main welding current generator is switched on with low field winding energisation the control current generator and electrical motor complete a circuit and the electrical motor is driven so that the wire electrode slowly approaches the workpiece.

When the wire electrode touches the workpiece the control current generator and electrical motor are short circuited through the weld and are starved of energisation. Hence the motor ceases to drive the wire electrode. The short-circuit current from the main generator is chosen to be sufficient to heat the wire electrode to just below its melting point. The apparatus is then in a condition ready for a welding operation, whereupon an auxiliary generator supplies a higher current to the field windings of the main generator, the control current generator and the electrical motor so that as the current from the main generator builds up the electrical motor is driven so as to lift the main electrode away from the workpiece thereby establishing an arc. As the voltage from the main generator increases to a value higher than that produced by the control current generator the polarity of the current fed to the electrical motor reverses and hence the electrode is driven down toward the workpiece. The control current generator and main generator are arranged to be in opposition so that the current fed to the electrical motor is always the resultant produced between the two, thereby producing a self-adjusting arc.

Apparatus of the kind described above works well with welding generators, but in some instances it is preferable to use power supplies of the static (i.e. transformer rectifier) type. However, with this type of equipment, problems arise because the output characteristics of such equipment are such that the wire electrode overheats when the short circuit condition is established. Accordingly it is an object of the present invention to provide arc welding apparatus in which these difficulties are alleviated.

The present invention in its broadest aspect subsists in apparatus for electric arc welding comprising a main welding current source arranged to supply current to a welding circuit comprising a movable wire electrode and a workpiece, an electrical motor arranged to drive the wire electrode towards and away from the workpiece in accord with the difference between the output voltages of the main welding current source and a control current generator so as to enable an arc formed between the wire electrode and the workpiece to be self-adjusting. The control current gener-

ator and the motor being rendered inoperative during short circuit between the wire electrode and workpiece, in which the main welding current source is arranged to provide a rectified direct current output from an input alternating current and there are provided means responsive to the potential difference across the welding circuit to control accordingly the polarity of current through the motor, an auxiliary power source arranged to provide direct current to the welding circuit such as to heat but not melt the wire electrode, switch means for connecting the main welding current source to the welding circuit and means for stopping the heating of the electrode by the auxiliary power source when the main welding current source is feeding the welding circuit.

The invention will be more readily understood by the following in which reference will be made to the accompanying drawing which illustrates schematically one embodiment of the invention.

Referring now to the drawing there is shown a main welding current source 1 connected across a welding circuit 2 comprising a wire electrode and a workpiece (not shown specifically). An auxiliary (starting) power source 3 is shown with its output connected in parallel with the output of the main welding current source 1. A control current generator 4 and an electrical motor 5 are shown with their armatures connected together in series relationship across the welding circuit via polarity relay contacts 6 and 7 and a main triple pole selecting switch 8. Auxiliary relay contacts 9 and 10 provide two further breaks in the circuit between the armature of the motor and the welding circuit 2 and between the triple pole switch and the welding circuit respectively. The polarity relay contacts are actuated by a polarity relay winding 11 which is coupled in series with another auxiliary relay contact 12 which is arranged to be normally closed and to be opened when an auxiliary relay coil 21 is actuated. The winding 11 and contact 12 are disposed across the welding circuit so that the polarity relay can only be energised when the auxiliary relay is de-energised and the welding circuit is presenting a high resistance. The polarity relay contacts 6 and 7 operate to reverse the polarity of the currents supplied by the control current generator 4 to the electrical motor 5 so that the motor is driven to advance the wire electrode toward the workpiece. When the wire electrode touches the workpiece the welding circuit short-circuits the energising winding 11 of the polarity relay, and the polarity relay reverts to its normal condition.

An auxiliary power supply 13 is arranged to supply current to the field winding 14 of the electrical motor 5, and to the field winding of the control current generator 4 either *via* a contact 15 of a main relay 16 and a voltage regulating rheostat 17 if the polarity relay coil 11 is de-energised and a contact 24 thereof is in the left-hand position shown in the drawing; or *via* a variable resistor 18 and a current regulating rheostat 19 if the polarity relay coil 11 is energised. The auxiliary power supply 13 is also arranged to supply current via the main triple pole selector switch 8 and a starting switch 20 to the energising coils 16 and 21 of the main relay and the auxiliary relay respectively. The main relay has a contact 22 in parallel with the starting switch 20 so that the starting switch may be released once the main relay has been energised, and a normally closed contact 23 in the circuit of the auxiliary starting power source 3 so that this auxiliary power source will be switched out of the circuit once the main welding current source has been switched on.

The operation of the circuit is then as follows. The main welding current source 1, auxiliary power supply 13 and auxiliary starting power source 3 are all switched on and the armature of the control current generator 4 is set in motion. The field winding 14 of the electrical motor 5 is always energised if the auxiliary power supply 13 is switched on. The triple pole selector switch 8 connects the auxiliary starting power source 3 across the welding circuit, connects the auxiliary power supply 13 across the starting switch 20 and the main relay contact 22 and connects the armature of the control current generator 4 in series with the armature of the electrical motor 5 across the welding circuit 2. This circuit is still broken by the contacts 9 and 10 of the auxiliary relay 21. The auxiliary starting power source 3 provides a potential difference across the welding circuit 2 which is sensed by the polarity relay coil 11 which actuates the contacts 6 and 7 to connect the armature of the control current generator 4 and electrical motor 5 in series so that the electrical motor drives the electrode wire (not shown) toward the workpiece. The coil 11 also actuates a contact 24 to connect the field winding of the control current generator 4 via a variable resistor 18 and a rheostat 19 across the auxiliary power supply 13. When the electrode touches the workpiece the potential difference across the welding circuit 2 collapses to zero, the polarity relay coil 11 is no longer energised and so the contacts 6, 7 and 24 revert to their normal positions connecting the control current generator 4 in opposite polarity to the electrical motor 5. The short circuit current from the starting source 3 through the wire electrode heats it to just below the melting point. The starting switch 20 may now be actuated; when this is done the main relay coil 16 and auxiliary relay coil 21 are energised, the contact 22 of the main relay locks on so that the starting switch 20, which may be of the push-button type, may be released. The contact 25 of the main relay is closed, connecting the main welding current source 1 across the welding circuit 2. The con-

tact 15 of the main relay is closed, connecting the field winding of the control current generator 4 in series with the voltage controlling rheostat 17, and the contact 23 of the main relay is opened, as the current from the main power source 1 increases, to disconnect the auxiliary starting power source 3 from the circuit. The contacts 9 and 10 of the auxiliary relay close to connect the armature windings of the control current generator 4 and the electrical motor 5 in series across the welding circuit 2; the polarity of the current, determined by the contacts 6 and 7 of the polarity relay, is such as to drive the electrical motor 5 to lift the wire electrode away from the workpiece in opposition to the current produced by the main power source 1 which tends to drive the electrical motor 5 so as to move the electrode toward the workpiece. The contact 12 of the auxiliary relay opens to disconnect the polarity relay coil so that the polarity relay is not energised once the main power source is supplying current to the welding circuit.

The control current generator 4 is designed so that its output current rises more rapidly once switched on than the output current of the main power source 1 so that the wire electrode is first lifted away from the workpiece to establish the arc and then, as the current from the main power source 1 overcomes the current from the control current source 4, the electrode is stopped and is fed down toward the workpiece. The position of the electrode is thereafter determined by the difference voltage produced between the main power source 1 and the control current generaor 4 to provide a 'self-adjusting arc'.

It will be understood that both the main welding current source 1 and the auxiliary starting power source 3 are of the 'static' (i.e. transformer/rectifier) type as is the supply 13 and accordingly provide a rectified direct current output from an alternating current input.

The circuit shown in the drawing includes a voltmeter across the welding circuit and an ammeter in series with the welding circuit.

WHAT WE CLAIM IS:—

1. Apparatus for electric arc welding comprising a main welding current source arranged to supply current to a welding circuit comprising a movable wire electrode and a workpiece, an electrical motor arranged to drive the wire electrode towards and away from the workpiece in accord with the difference between the output voltages of the main welding current source and a control current generator so as to enable an arc formed between the wire electrode and the workpiece to be self-adjusting, the control current generator and the motor being rendered inoperative during short circuit between the wire electrode and workpiece, in which the main welding current source is arranged to provide a rectified direct current output from an input alternating current and there are provided means responsive to the potential difference across the welding circuit to control accordingly the polarity of current through the motor, an auxiliary power source arranged to provide direct current to the welding circuit such as to heat but not melt the wire electrode, switch means for connecting the main welding current source to the welding circuit and means for stopping the heating of the electrode by the auxiliary power source when the main welding current source is feeding the welding circuit.

2. Apparatus as claimed in claim 1 in which the means responsive to the said potential difference is arranged to reverse the polarity of current supplied by the control current generator to the electrical motor when the welding circuit is not short circuited and thereupon to cause the motor to drive the wire electrode towards the workpiece.

3. Apparatus as claimed in either claim 1 or claim 2 in which the control current generator and the electrical motor have their armatures connected in series across the welding circuit.

4. Apparatus as claimed in any preceding claim in which the control current generator is designed so that its output voltage rises more rapidly once the generator is excited than does the output voltage of the main welding current source.

5. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

BOULT, WADE & TENNANT
112 & 114, Hatton Garden, London, E.C.1.
Chartered Patent Agents,
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1971.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1245589 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*